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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte RUSSEL MORRIS, CHRISTIAN SERRE, PATRICIA HORCAJADA CORTES, ALEXANDRE VIMONT, THOMAS DEVIC, and GERARD FEREY[1]

Appeal 2016-003824
Application 12/935,642
Technology Center 1600

Before TAWEN CHANG, RYAN H. FLAX, and RACHEL H. TOWNSEND, *Administrative Patent Judges*.

FLAX, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134(a) involving claims directed to a porous crystalline metal-organic framework (MOF) solid loaded with at least one Lewis base gas. Claims 1–8 and 10–15 are on appeal as rejected under 35 U.S.C. § 103(a). We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

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[1] We understand the Real Parties in Interest to be Centre National de la Recherche Scientifique (CNRS), University of Saint Andrews, Universite de Versailles - Saint-Quentin-en-Yvelines, and Ensi Caen. Br. 1.

STATEMENT OF THE CASE

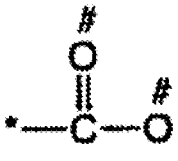
The Specification states "[t]he MOF solids of the present invention are capable of adsorbing and releasing gases of biological interest in a controlled manner. They can be used in the pharmaceutical field and/or for applications in the cosmetics field. They can also be used in the food industry." Spec. 1:13–18.[2]

The appealed claims can be found in the Claims Appendix of the Appeal Brief. Claim 1 is the sole independent claim, is representative, and reads as follows:

> 1. A porous crystalline MOF solid loaded with at least one Lewis base gas selected from the group consisting of NO, CO and H_2S, at least a part of which coordinates with M, said solid comprising a three-dimensional succession of units having the following formula (I):
>
> $$M_mO_kX_lL_p \qquad (I)$$
>
> in which:
>
> • each occurrence of M independently represents an ion of a transition metal M^{z+} wherein M is Fe and in which z is 2 or 3, wherein approximately 15 to 20% of the Fe is reduced from Fe^{3+} to Fe^{2+};
>
> • m is 1 to 12;
>
> • k is 0 to 4;
>
> • l is 0 to 18;
>
> • p is 1 to 6;

[2] When citing to the Specification (Spec.) herein, we refer to the English translation of International Patent Application No. PCT/FR2009/000381 dated Oct. 11, 2010.

• X is an anion chosen from the group comprising OH^-, Cl^-, F, I^-, Br^-, SO_4^{2-}, NO_3^-, ClO_4^-, PF_6^-, BF_4^-, R-$(COO)_n^-$ where R is as defined below, R^1-$(COO)_n^-$, R^1-$(SO_3)_n^-$, R^1-$(PO_3)_n^-$, where R^1 is a hydrogen, a linear or branched, optionally substituted, C_1 to C_{12} alkyl, or an aryl, and where n is an integer from 1 to 4;

• L is a spacer ligand comprising a radical R comprising q carboxylate groups  , where

- q is 2, 3, 4, 5 or 6;

- * denotes the point of attachment of the carboxylate with the radical R;

- # denotes the possible points of attachment of the carboxylate to the metal ion;

- R represents:

(i) a C_{1-12} alkyl, C_{2-12} alkene or C_{2-12} alkyne radical;

(ii) a fused or nonfused, monocyclic or polycyclic aryl radical containing 6 to 50 carbon atoms;

(iii) a fused or nonfused, monocyclic or polycyclic heteroaryl containing 1 to 50 carbon atoms;

(iv) an organic radical comprising a metal element chosen from the group comprising ferrocene, porphyrin and phthalocyanin;

the R radical being optionally substituted with one or more R^2 groups, independently chosen from the group comprising C_{1-10} alkyl; C_{2-10} alkene; C_{2-10} alkyne; C_{3-10} cycloalkyl; C_{1-10} heteroalkyl; C_{1-10} haloalkyl; C_{6-10} aryl; C_{3-20} heterocyclic; (C_{1-10})alkyl(C_{5-10})aryl; (C_{1-10})alkyl(C_{3-10})heteroaryl; F; Cl; Br; I;

$-NO_2$; -CN; $-CF_3$; $-CH_2CF_3$; -OH; $-CH_2OH$; $-CH_2CH_2OH$; $-NH_2$; $-CH_2NH_2$; -NHCHO; -COOH; $-CONH_2$; $-SO_3H$; $-CH_2SO_2CH_3$; $-PO_3H_2$; or a $-GR^{G1}$ function in which G is -O-, -S-, $-NR^{G2}$-; -C(=O)-, -S(=O)-, $-SO_2$-, -C(=O)O-, $-C(=O)NR^{G2}$ -, -OC(=O)-, $-NR^{G2}C(=O)$-, -OC(=O)O-, $-OC(=O)NR^{G2}$ -, $-NR^{G2}C(=O)O$-, $-NR^{G2}C(=O)NR^{G2}$ - or -C(=S)-, where each occurrence of R^{G1} is, independently of the other occurrences of R^{G1}, a hydrogen atom; or a linear, branched or cyclic, optionally substituted, C_{1-12} alkyl, C_{1-12} heteroalkyl, C_{2-10} alkene or C_{2-10} alkyne function; or a C_{6-10} aryl, C_{3-10} heteroaryl, C_{5-10} heterocyclic, (C_{1-10})alkyl(C_{5-10})aryl or (C_{1-10})alkyl(C_{3-10})heteroaryl group in which the aryl, heteroaryl or heterocyclic radical is optionally substituted; or else, when G represents $-NR^{G1}$, it forms together with the nitrogen atom to which it is bonded, a heterocycle or a heteroaryl which is optionally substituted;

wherein the pores of the MOF solid are empty of solvent and are loaded with said at least one Lewis gas base.

Br. 16–17 (Claims App'x). Claim 15 is also relevant and reads as follows:

15. The solid according to claim 14, in which the organic surface agent is selected from the group consisting of:

- an oligosaccharide, for instance cyclodextrins,
- a polysaccharide, for instance chitosan, dextran, fucoidan, alginate, pectin, amylase, starch, cellulose or xylan,
- a glycosaminoglycan, for instance hyaluronic acid or heparin,
- a polymer, for instance polyethylene glycol (PEG), polyvinyl alcohol or polyethyleneimine,
- a surfactant, for instance pluronic or lecithin,
- vitamins, for instance biotin,
- coenzymes, for instance lipoic acid,
- antibodies or antibody fragments,

- amino acids or peptides.

Id. at 20.

The following rejections are on appeal:

Claims 1–8 and 10–14 stand rejected under 35 U.S.C. § 103(a) over Morris[3] and Xie.[4] Final Act. 2.

Claim15 stands rejected under 35 U.S.C. § 103(a) over Morris, Xie, and Kwon.[5] *Id.* at 6.

DISCUSSION

We adopt the Examiner's findings of fact, reasoning on scope and content of the prior art, and conclusions set out in the Final Action and Answer. We find the Examiner has established that the claims would have been obvious over Morris and Xie, and, in the case of claim 15, also Kwon. Appellants have not produced evidence showing, or persuasively argued, that the Examiner's determinations of obviousness are incorrect. Only those arguments made by Appellants in the Brief have been considered in this Decision. Arguments not presented in the Brief are waived. *See* 37 C.F.R. § 41.37(c)(1)(iv) (2015). Appellants argue all claims together, except 15, and we have identified claim 1 as representative. Therefore, all claims, but 15, fall with claim 1.

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[3] International Patent Application Pub. No. WO 2008/020218 A1, published February 21, 2008 (hereinafter "Morris").
[4] Linhua Xie et al., *Mixed-Valence Iron(II, III) Trimesates with Open Frameworks Modulated by Solvents*, 46 INORG. CHEM. 7782–88 (2007) (hereinafter "Xie").
[5] U.S. Patent Application Pub. No. US 2005/0179012 A1, published August 18, 2005 (hereinafter "Kwon").

The Examiner determined that all the elements of claim 1 are taught by Morris, except specifically the limitation, "an ion of a transition metal M^{z+} wherein M is Fe and in which z is 2 or 3, wherein approximately 15 to 20% of the Fe is reduced from Fe^{3+} to Fe^{2+}," which the Examiner found to be taught by Xie. Final Action 2–4. Morris and Xie are directed to the same technological field and the Examiner determined that the skilled artisan would have looked to Xie to teach that the Fe^{3+} and Fe^{2+} disclosed by Morris would be provided together and in the amounts/percentages recited by claim 1 because (a) Xie teaches that these Fe ions, at these valences, are particularly useful as active sites in porous metal-organic frameworks for biological systems and (b) also because Xie teaches "that the valences of iron atoms can be modulated" to achieve desired characteristics. *Id.* at 4.

Appellants argue that it is not possible to combine Morris and Xie because Xie indicates that heating will destroy its MOF frameworks and Morris requires heating to activate its MOF (i.e., to remove unwanted material, e.g., solvent, from its pores). Br. 11. Appellants' argument is not persuasive because heating is just one way Morris teaches MOF activation; other Morris-disclosed methods of activation include reducing pressure, exposure to electromagnetic radiation, exposure to other solvents, and physical displacement by the gas molecules sought to be held in the pores. *See* Morris 8–11.

Appellants argue Xie teaches away from the invention because it states "Fe^{2+} is air-sensitive and readily changes into Fe^{3+}, and Fe^{3+} has a strong tendency to undergo hydrolysis into a stable polymeric hydrous iron oxide even in a strongly acidic environment." Br. 12 (citing Xie 7783).

The test of obviousness is "whether the teachings of the prior art, taken as a whole, would have made obvious the claimed invention." *In re Gorman*, 933 F.2d 982, 986 (Fed. Cir. 1991). Further, a finding of "teaching away" requires a reference to actually criticize, discredit, or otherwise discourage the claimed solution. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004).

While Xie indicates that "investigations of ion-organic frameworks are less common compared with those of zinc and copper" because of an air-sensitivity, etc., Xie nevertheless reports on a study of Fe ions with open frameworks, conducted in view of advantages of Fe in biological systems. Xie 7783 (left col.). Moreover, Xie demonstrates success in making open iron-organic frameworks having a "character [that] may allow modulations of iron-organic frameworks to obtain porous materials with walls containing electron-active sites and special sized and shaped pores, which are of great importance in many potential applications . . . ." *Id.* at 7788. Thus, we do not find Xie, as a whole, discourages the use of iron in MOF frameworks. Indeed, to the contrary, Xie, provides motivation to use iron in such structures.

Appellants argue that even if Morris and Xie were combined, they would not teach "the presently-claimed MOF solid in which approximately 15 to 20% of the Fe is reduced from Fe^{3+} to Fe^{2+}." Br. 13. This is not persuasive.

> Xie expressly discloses an Fe^{3+} : Fe^{2+} ratio of 78:22 and also that,
>
> The valences of iron atoms are changeable in solvothermal conditions; thus, the frameworks can be readily affected by solvents (or possibly some other factors) in the process of

> crystallization. This character may allow modulations of iron-organic frameworks to obtain porous materials with walls containing electron-active sites and special sized and shaped pores, which are of great importance in many potential applications, such as gas storage and catalysis.

Xie 7787 (left col.), 1788 (right col.).

Our reviewing court has held,

> In cases involving overlapping ranges, we and our predecessor court have consistently held that even a slight overlap in range establishes a *prima facie* case of obviousness. . . . We have also held that a prima facie case of obviousness exists when the claimed range and the prior art range do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties.

In re Peterson, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (note, all ranges in *Peterson* overlapped, but close ranges are nevertheless obvious).

We find that the 22% Fe^{2+} disclosed by Xie in the above-identified ratio discloses "*approximately* 15 to 20%," as recited by claim 1 (emphasis added), or renders the recited 20% obvious. Xie is clear that the percentage of Fe^{2+} is a results effective variable such that its optimization would be merely routine and obvious.

Regarding claim 15, directed to providing an organic surface agent, e.g., the natural polymer dextran, at the surface of the MOF of claim 1, the Examiner added Kwon to the prior art combination because Morris teaches that its monoliths can be made by mixing a powdered organic framework with a suitable binder, e.g., a polymeric binder, and Kwon disclosed that iron (Fe^{2+} and Fe^{3+}) oxides can be mixed with an organic binder, such as dextran, to form a paste. *See* Final Action 7; Ans. 20–21; Morris 15; Kwon ¶ 64. Appellants argue that in the claimed invention, "dextran is used as a surface

agent," and the "dextran . . . used in order to form **a mixed matrix**" in Kwon "is completely different" than dextran used "to modulate the external surface properties of the material to adapt it for therapeutic administration." Br. 14. We disagree with Appellants' analysis.

As the Examiner identified, if one reference discloses a solution to a problem that is reasonably pertinent to a problem of another reference, it is obvious to combine the two for that purpose. *In re Oetiker*, 977 F.2d 1443, 1447 (Fed. Cir. 1992). Moreover, it is obvious to those skilled in the art to substitute one known equivalent for another. *See In re Omeprazole Patent Litigation*, 483 F.3d 1364, 1374 (Fed. Cir. 2007) ("[T]his court finds no . . . error in [the] conclusion that it would have been obvious to one skilled in the art to substitute one ARC [alkaline reactive compound] for another."). Here, the Examiner has established that the dextran of Kwon used for a binder would have been obvious to use as a binder for the monolithic MOF structures of Morris.

We note that claim 15 does not recite any particular function for the "organic surface agent," just that the MOF of claim 1 comprises, "at its surface at least one organic surface agent" than can be dextran. We note that the Specification teaches that the "organic surface agent" can either partially or totally cover the surface of the MOF, and may "be incorporated by entanglement during the manufacture of the MOF solids." Spec. 21:19–33. As noted above, Morris teaches a binder is incorporated with the MOF during the manufacture of the MOF solid. Morris 15. We find therefore, implicit in the Examiner's rejection (Ans. 7, 20), that use of Kwon's dextran as the binder in Morris would result in at least some of the binder being at

the surface of the MOF that includes iron due to its entanglement during the manufacture of that solid. We find that the Examiner properly presented a prima facie case of unpatentability concerning claim 15, *Oetiker*, 977 F.2d at 1447, and Appellants have not presented evidence or persuasive argument establishing the Examiner's determination is incorrect.

SUMMARY

The rejections under 35 U.S.C. § 103(a) are affirmed.

TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED